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Research Kernels

Our Latest Research Results • March 2008

Monitoring flour beetles in pilot-scale warehouses treated with B-cyfluthrin: are residual insecticides and trapping compatible?

Integrated pest management strategies for cereal processing facilities often include both pheromone-baited pitfall traps for population monitoring and crack and crevice applications of a residual insecticide for control. It is unknown how insecticide applications may be affecting the insect captures in the traps. In a 15-wk study conducted in pilot-scale warehouses, we showed that the use of a residual insecticide greatly increased mortality of adult red flour beetles and thereby decreased their capture in the pheromone traps. However, the insect population density in food patches remained at similar levels regardless of insecticide treatment. These data suggest that pest management professionals find complementary alternative methods of population estimation when used concurrently with residual pesticides.

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A novel source of resistance in wheat to Pyrenophora tritici-repentis Race 1

Tan spot is a foliar disease that causes serious yield losses in wheat and many other grasses. Genetic resistance to tan spot has been successful, but new sources of resistance are needed to achieve higher levels of disease control. A mapping population from the cross between the Indian spring wheats WH542 (resistant) and HD29 (moderately-susceptible) was evaluated for reaction to the disease. Genes for resistance were detected on chromosome 3A explaining 23% of the variation, and on chromosome 5B explaining 27% of the variation for resistance. Both resistance genes were contributed by the WH542 parent. The gene on 5B is probably tsn1, which was described previously. The gene on 3A is a novel gene for resistance to tan spot. Markers were found that are suitable for marker-assisted selection for tan spot resistance.

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Monitoring stored grain with relative humidity, temperature, and carbon dioxide sensors

A simulated grain storage was monitored during aeration to determine if a high-moisture grain in the bin top could be detected using relative humidity (RH), temperature (T), and carbon dioxide (CO2) sensors. RH and T sensors data were combined to indicate the equilibrium moisture content (EMC) of the grain. Sensors were placed at different depths in the bin. The wet grain produced high amounts of CO2, which, in most cases, was easily detectable during aeration. Lowering grain temperature with aeration diminished the amount of CO2 produced making it more difficult to detect unless the CO2 sensor was located very close to the wet grain. The moisture content of the grain increased downstream of the high-moisture grain during aeration as indicated by the EMC data. Simultaneous monitoring of stored grain with these sensors should improve storage management by detecting problematic conditions quickly so corrective measures could be taken.

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A model for prediction of heat stability of photosynthetic membranes

We developed a model for prediction of thermal damage to photosynthetic membranes. The prediction model relies on chlorophyll content as a predictor. The model was tested in over 50 genotypes of wheat and maize, and it adequately predicted the heat stability of photosynthetic membranes in all genotypes. The model offers a new approach for quick and inexpensive means of assessing the integrity of photosynthetic membranes in hot environments thereby providing information on the overall physiological state and heat stress tolerance in wheat and maize. The model could potentially be used in other crop plants, as the verification of the model showed that it is not species-specific. For assessment of photosynthetic membrane damage, control plants may not be necessary as the model can predict membrane damage using chlorophyll content from heat-stressed plants.

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Expression and function of sex pheromones and receptors in the Homothallic Ascomycete

In ascomycete fungi, there are two sex pheromone/receptor pairs that function in recognition and attraction of strains with opposite mating types. In the ascomycete *Gibberella zeae*, cause of Fusarium head blight of wheat and barley, we identified both putative pheromone precursor genes and their corresponding pheromone receptor genes. Gene knock-out mutants showed that one of the putative pheromone/receptor pairs enhances, but is not essential for, selfing and outcrossing in *G. zeae*, whereas no functional role was found for the other pair. The functional sex pheromone could be a target for novel control strategies for this pathogen.

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Efficacy of *Beauveria bassiana* for control of *Tribolium castaneum* with reduced oxygen and increased carbon dioxide

This study investigated the effect of the efficacy of the insecticidal fungus *Beauveria bassiana*, on one of the most difficult to control pests, the red flour beetle. Atmosphere modification, is a widely adopted means of insect control in stored products. Oxygen reduction but not carbon dioxide elevation for the first 72 hours of fungus exposure resulted in greater larval mortality than was observed with fungus exposure under ambient atmospheres. Both treatments reduced pupation of older larvae suggesting that slowed development may be a beneficial factor for fungal efficacy. Carbon dioxide elevation, but not oxygen reduction significantly affected the mortality of adult beetles. Carbon dioxide elevation significantly reduced fungus germination and growth rates, but oxygen reduction affected only the growth rate. This research contributes to the search for non-chemical methods to control insect pests in stored commodities.

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Heterologous expression of a plastid EF-Tu reduces protein thermal aggregation and enhances CO2 fixation in wheat following heat stress

Heat stress is a major constraint to wheat production and negatively impacts grain quality, causing tremendous economic losses, and may become a more troublesome factor due to global warming. At the cellular level, heat stress causes aggregation of proteins and injury to membranes leading to reduction in photosynthesis. Here we report on the development of transgenic wheat, expressing a maize gene for a chloroplast protein called EF-Tu, that displays reduced thermal aggregation of leaf proteins, reduced heat injury to photosynthetic membranes, and enhanced rate of photosynthesis after exposure to heat stress. The results suggest that heat tolerance of wheat, and possibly other crop plants, can be improved by modulating expression of chloroplast EF-Tu and/or by selection of plants with increased natural levels of this protein.

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Environmental events affecting starch size distribution in developing hard red winter wheat caryopsis

Starch constitutes the greatest weight portion of the wheat endosperm (65-75%) and contributes its own unique functional qualities such as texture, volume, consistency, aesthetics, moisture, and shelf stability to various baked products. While genetics is the dominant determinant in caryopsis development the environment also has a critical role in quality variability. Starch particle size has long been recognized as an important variable in the efficiency of a range of processes including predicting rheology and flow behavior. This study assessed starch size distribution in five varieties of hard red winter wheat grown in the same location over seven consecutive years. Environmental events such as changes in soil temperature, cumulative precipitation and cumulative evapo-transporation caused shifts in starch size distributions in most varieties studied. This and similar studies are critical in determining how the environment impacts cereal development as well as how this variability in starch size distribution will affect cereal usage and quality.

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